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PRESERVATION OF RECORDS IN LIBRARIES

The librarian has been given some effective weapons to combat the decay of stored records in his care, by research conducted at the Bureau during the past 4 years. Through the interest of librarians, appalled at the spectacle of valuable records crumbling to dust, the Carnegie Corporation allotted research funds to the National Research Council to find remedies for the situation. These, supplemented by Government funds, permitted a systematic study at the Bureau to find causes and curatives. The results of this work as a whole are summarized in Miscellaneous Publication No. 144, which has just been issued.

A survey of the condition of printed material in important libraries in various localities of the United States, and study of the storage methods, indicated that the unseen forces of light, adverse temperature and humidity, and acidic gases in polluted air were all taking their toll. Some of the librarians' trouble is due of course to poor paper. While all of these agents of deterioration had been quite com-

monly regarded with suspicion, there had been before no systematic effort to define their influences or to find means of overcoming their effects.

The Bureau exposed papers to sunlight and to light from a carbon-arc lamp, which simulates sunlight quite closely, and measured their loss of folding endurance. In both cases, all grades of papers weakened rapidly. The folding endurance of even high-grade papers decreased as much as 63 percent on 100 hours' exposure of each side of the papers to sunlight, with little or no discoloration. Light, then, may damage otherwise stable papers without the deterioration being apparent to the librarian. The use of diffused artificial light, and as little of it as possible, is the remedy suggested.

Sulphide dioxide in the air, from the combustion of fuels, had been proved by other investigators to be a deteriorant of a wide variety of materials, since it readily oxidizes to corrosive sulphuric acid. Paper was found to be no exception. Printing and writing papers were exposed to atmospheres containing sulphur dioxide in a specially constructed cabinet where tem-

perature, humidity, and amount of sulphur dioxide could be regulated to simulate library atmospheric conditions in polluted areas. In only 10 days' exposure all grades of paper weakened greatly; the best ones lost as much as 30 percent of their initial folding endurance. Tests of the papers from the same issues of books stored in libraries in different localities corroborated the effects of sulphur dioxide found in the laboratory, in a remarkable way invariably the papers of books stored in polluted atmospheres were acid, and in a poorer state of preservation than those of books stored in relatively pure air. Having shown definitely the deteriorating effect of acidic air, the Bureau found through experimental tests in a library, means of eliminating this hazard. A specific commercial alkaline compound in the water used to wash the library air completely removed the acid. Moreover, this compound prevents the corrosion of the air-treating equipment resulting from acid gases.

Extremes of temperature and humidity of library air are said to promote mildew, and the chemical reactions that cause embrittlement. The use of carefully controlled air-conditioning apparatus to maintain a medium degree of temperature and humidity, favorable to both printed material and human beings, is recommended.

Extensive tests of papers from old newspapers and books brought out forcibly the need of good fibers for permanence. Papers containing crude fibers such as ground wood were in generally bad condition and those containing chemically purified fibers were in generally good condition. Ground wood fibers were used in the past in all classes of publications and the test data serve to outline definitely the time periods of such practice.

Prolonging the life of records contained on impermanent papers was studied to some extent but not thoroughly as yet. Coatings of Japanese tissue paper have proved effective, and transparent cellulose acetate sheeting appears to be suitable. Permanent photostat paper is recommended for reproducing records of perpetual value.

The usual acid types of writing inks weakened papers rapidly when their action was accelerated by heat. An alkaline type of ink was developed which offers considerable promise.

Insects which devour books and bookbinding materials are a prolific source of trouble. An outline is given of information developed elsewhere on

protective measures against such pests. The so-called "bookworms"—not the human kind—is very difficult of extermination, but the Huntington Library successfully combats it by use of a new fumigant, "carboxide", in a vacuum chamber.

The Bureau has necessarily discontinued these studies because of exhaustion of the funds available for them, but hopes that means may be found later to continue them. Further study of protective materials for record papers, such as coatings, impregnations, and materials that might be incorporated in the papers in the course of their manufacture, is mentioned as being desirable for securing additional information of much potential value.

TRANSPARENT CELLULOSE SHEETING FOR PRESERVING RECORDS

The Bureau has found that the acetate type of transparent cellulose sheeting offers considerable promise as a protective covering for preserving valuable written or printed records. The high degree of transparency, tensile strength, and smoothness of cellulose sheetings are attractive features for this use. The cellulose acetate sheeting appears to be particularly well adapted since it is apparently very stable if made from high-grade cellulose, can be secured in sheets only one-thousandth of an inch thick, and is thermoplastic, that is, can be applied by combined heat and pressure. The paper bearing the record is placed between two slightly larger sheets of the cellulose sheeting, and the combination is pressed between heated platens in a hydraulic press. This forms a smooth, firmly bound unit, with edges sealed by the overlapping edges of the cellulose sheeting. The last feature is important because it makes the combination quite impervious to air.

OPACITY OF PAPER

One of the essential requirements for printing paper is that it shall be sufficiently opaque to prevent the print on the back from showing through. Opacity is technically defined by contrast ratio which is the brightness of the paper backed by a certain black surface divided by its brightness when backed by a certain white surface. A reproducible and practical black backing may be obtained by using a black-lined cavity, but the reproducible white surface specified in the definition of contrast ratio is magnesium oxide which is very fragile. Instruments

used in the paper industry for measuring opacity have generally substituted less fragile white surfaces for magnesium oxide, block magnesium carbonate being most widely used; and to protect the white surface and sample, they are kept from touching. The opacimeter specified in the official method of the Technical Association of the Pulp and Paper Industry for determination of opacity of paper uses block magnesium carbonate separated from the sample by a cover glass.

There have been recurring instances of errors in measuring opacity of paper by the official contrast-ratio method. RP660 in the March number of the Journal of Research, deals with errors associated with the use of white surfaces the reflectance of which is different from that of magnesium oxide, and with errors produced by separating the sample from the white backing. A modification of the official contrast-ratio method is suggested which promises to avoid difficulties arising from these sources of error.

PHASE CHANGES IN RUBBER AS INDICATED BY TEMPERATURE-VOLUME MEASUREMENTS

The change in volume of rubber with temperature has been investigated from -85 to $+85$ C. in connection with a study of the heat capacity and related thermodynamic properties of rubber. The immediate purpose was to determine the phases in which rubber may exist, the temperatures at which transitions from one phase to another occur, and the periods of time required for transition to take place under various circumstances.

Measurements of volume change were made by enclosing samples of rubber with suitable confining liquids in dilatometers of pyrex glass and observing the changes in height of the liquid in the calibrated capillary tubes of the dilatometers. Water, alcohol, acetone, and mercury were used as confining liquids in temperature ranges for which they were respectively suitable.

The samples employed included crude rubber, purified rubber in both the sol and the gel modifications, and vulcanized compounds containing 2, 4, and 6 percent of combined sulphur, respectively.

The principal phase change observed was the one attendant on the well-known phenomenon of the "freezing" or raw rubber, previously studied by Bunschoten, Van Rossem, and other investigators. The same phase change is probably involved in the melting of

rubber crystals as reported in the Journal of Research for April 1933 (RP544). The transition from the ordinary form of rubber to the more dense or "frozen" form was found to occur at about 5 to 15 C with a decrease in volume of approximately 2.7 percent. The transition was practically the same with the purified rubber as with the crude rubber, but no indication of any comparable change was observed in the case of the vulcanized samples.

The rate of change from the ordinary to the more dense form was found to depend on the temperature. At 0 C about 10 days were required for the practical completion of the volume change; at somewhat lower temperatures, less time was required, but at still lower temperatures, the rate became very slow. No measurable indication of transition was observed, for example, when a sample was held below -40 C for 3 weeks.

When samples which had been cooled rapidly to below -40 C were warmed slowly the transition occurred with a decrease in volume which so overshadowed the effect of thermal expansion, as to give the appearance of a negative coefficient of thermal expansion. Heat capacity measurements made under similar circumstances indicated that heat was evolved as the sample was warmed. This was to be expected since the transition is accompanied by a relatively large latent heat effect.

The transition from the more dense form back to the ordinary form was not observed to take place below the range 5 to 15 C. At temperatures below this the more dense form is apparently stable.

A second type of transition, characterized by a marked change in coefficient of thermal expansion, was observed at considerably lower temperatures in the case of all samples of rubber, both vulcanized and unvulcanized.

When unvulcanized rubber was cooled without delay from room temperature to -70 C the coefficient of expansion decreased from approximately 0.00070 to approximately 0.00065 vol/vol/ $^{\circ}$ C. Between -70 and -76 C, however, a change occurred lowering the coefficient to approximately 0.00025 vol/vol/ $^{\circ}$ C. Rubber in the more dense form exhibited similar behavior. The coefficient was about 0.00065 vol/vol/ $^{\circ}$ C. at 0 C and decreased to about 0.00060 vol/vol/ $^{\circ}$ C. in the neighborhood of -70 C, be-

low which it dropped to approximately 0.00025. The temperatures at which the changes in coefficient of expansion occur for the two forms of rubber have not yet been determined with sufficient precision to say whether they are the same or differ slightly.

Measurements of the heat capacity of pure, unvulcanized rubber which are in progress show an anomaly in the range of -70 to -76 C. This probably corresponds to the change in the coefficient of thermal expansion.

Measurements of electrical properties which were made at temperature intervals of about 5 C in connection with another investigation, gave no indication of anomaly, but when the measurements were repeated with precision at intervals of one degree, a small but definite change in dielectric constant was observed at -73 to -74 C.

It would seem reasonable also to associate this phase change with the hardening and brittleness which is observed when rubber is cooled quickly to low temperatures. However, in-

vestigators who have studied the latter phenomenon find that it occurs in the case of unvulcanized rubber at about 55 C, which is not in accord with the present findings.

The vulcanized rubber samples showed changes in the coefficient of expansion similar to those for unvulcanized rubber at somewhat higher temperatures. The compound containing 2 percent of sulphur showed the change at about -72 C; for 4 percent of sulphur, the change occurred at about -62 C, and for 6 percent, at about -53 C.

COLLOIDAL MATERIAL OF AMERICAN CHINA CLAYS

The percentages of material less than 0.6 micron in diameter were determined for nine American kaolins, using the water adsorption method. Partial chemical analyses of this fine material were made to determine the silica-sesquioxide ratio. The following results were obtained:

Clay	Location	Material less than 0.6 micron	SiO ₂ :R ₂ O ₃ ratio
		Percent	
R	Delaware	26	1.66
S	North Carolina	32	1.93
T	South Carolina	35	1.66
U	Georgia	34	2.02
V	Georgia	31	1.88
W	Georgia	36	2.00
X	Florida	56	1.92
Y	Florida	57	1.92
Z	Florida	46	1.91
Average for 15 English china clays		32	2.22

It will be noted that the Delaware, North Carolina, South Carolina, and Georgia clays average about the same amount of fine material as the English china clays, while the Florida clays show averages more nearly approaching those of ball clays.

Some soils workers have laid considerable stress on the silica-sesquioxide ratio as a corollary to the relative activity of particle surfaces, and as giving some indication of the processes involved in the weathering of the soils. The English china clays show a higher value for this ratio than the American kaolins. It is possible that this difference may have developed in the different climatic conditions of weather to which the clays were subjected.

The chemical analyses showed the fine material from the American kaolins to be practically free from RO compounds. This was not true of the

fine fractions of the English china clays, which contained anywhere from 1 to 9 percent of these compounds, probably due to the presence of the weather-resistant mineral, muscovite.

REACTIONS BETWEEN SILVER BROMIDE AND PHOTOGRAPHIC SENSITIZERS

The sensitivity of photographic emulsions may be greatly increased by digestion with traces of certain compounds; the best known of these is allyl thiocarbamide, which is found in photographic gelatin. The conditions of photographic sensitization by these compounds are such that it appears probable that a chemical reaction takes place between the silver bromide of the emulsion and the sensitizer. In the case of the allyl thiocarbamide, the product is silver sulphide. Recent work at the Bureau has shown that sodium sulphite, reacting with silver bromide to give metallic silver, is also

a sensitizer. The chemical reactions of these two sensitizers with silver bromide have been studied by following the change in bromide-ion concentration in the solutions. Both are strongly retarded by acid and by soluble bromide, which are products of the reactions. The reaction with allyl thiocarbamide is catalyzed by its own product, silver sulphide. The reaction kinetics are too complex for complete analysis, but the data strongly indicate that the reaction takes place by decomposition of dissolved material at the surface of the silver sulphide. Data on solubilities and adsorptions, obtained to assist in interpretation, are given in RP659 in the March number of the Journal of Research. The reaction with sodium sulphite is also autocatalytic, and it seems probable on theoretical grounds that this is an essential characteristic of the sensitization process.

UNIFORMITY OF GRADES OF LOVIBOND RED GLASSES

The need for uniformly graded Lovibond red glasses has long been urgent among those engaged in the vegetable and cottonseed-oil trade. Great quantities of oil are yearly bought and sold with color as an important contributing factor in the rules governing the transactions. The grade of the oil depends upon its color, and the color is defined in terms of Lovibond glasses. The calibration of these red glasses in terms of the standard unit and scale, known as the Priest-Gibson unit and scale, has been in progress at the Bureau since 1928. A report of this work will be published as RP653 in the March number of the Journal of Research. By direct comparison with the working standards a new value of regrade numeral is assigned to each glass submitted for test. The new value is the effective additive value when the glass is used in combination with a 35-yellow (35Y) glass.

The statistical investigation of the data resulting from the calibration of the first 1,000 red glasses shows that variations of a whole unit frequently exist among glasses of similar Lovibond numeral. Several illustrations display in different ways the discrepancies found among these glasses. For purposes of the oil trade, not only should all glasses of the same color bear the same numeral, but also, those of different colors should bear the corresponding proper numerals according to a scale which is accurately additive. Both regular and erratic departures

from additivity have been demonstrated in the Lovibond scale as embodied in these 1,000 red glasses combined with 35Y, and the additive nature of the Priest-Gibson scale has been confirmed.

PURE-METAL RESISTANCE STANDARDS

The unit of electrical resistance known as the International Ohm is defined in terms of a column of mercury of stated dimensions, measured under specified conditions. The unit for this country, however, has been maintained since 1910 by means of wire-wound standards. It is assumed that the average resistance of a group of manganin coils remains constant. Manganin is an alloy of copper, nickel, and manganese, and is, therefore, liable to change in structure and to suffer from surface corrosion.

While manganin coils seem to be highly satisfactory for use in maintaining the unit of resistance, more information is desired as to their stability. Mercury ohm or absolute ohm determinations cannot yet be made with a sufficient accuracy to give this information. A possible procedure is to construct additional groups of standards, using radically different resistance materials, and to compare the relative stability of all the groups.

It would be expected that pure metals not liable to corrosion would be more stable in resistance than base-metal alloy. They are not used, however, because of their large temperature coefficients of resistance. To measure a pure-metal coil to a part in a million would require a temperature which could be reproduced to one or two ten-thousandths of a degree Centigrade.

In order to investigate the possibilities of pure-metal standards, 1-ohm coils have been constructed of copper, silver, tin, gold, and platinum wire. These standards have been measured at the temperature of melting ice, and the gold and platinum standards have been very stable in resistance. It has been found possible to reproduce the ice point to a few ten-thousandths of a degree C. In RP657 in the March number of the Journal of Research will be found a description of the construction of the pure-metal standards and the method of measurement. The data obtained make it seem probable that either gold or platinum standards could be used to maintain the unit of electrical resistance or to investigate the stability of manganin standards.

REPRODUCIBILITY OF THE ICE POINT

One of the most important fixed points on any temperature scale is the melting point of ice. Since the temperature of an ice bath depends upon the impurities present in the bath, and upon the barometric pressure, the ice point is generally supposed to be uncertain to one or two thousandths of a degree Centigrade.

Investigations of the ice point, made in connection with experiments on pure-metal resistance standards, indicate that the ice point is readily reproducible to a few ten-thousandths of a degree Centigrade, even when commercial ice is used. This result is based upon comparisons of the temperature obtained with different ice baths, and upon comparisons of the temperature of ice baths with that of the triple point of water. RP658 in the Journal of Research for March contains a description of the measurements and the data from which this conclusion is drawn.

VARIATIONS IN ISOTOPIC COMPOSITION OF WATER FROM VARIOUS NATURAL SOURCES

Differences in the isotopic composition of waters from various natural sources have been detected as the result of determinations of their densities carried out at the Bureau and described in the March Journal of Research (RP656). After the removal of all nonaqueous constituents, the water of the Dead Sea and of Great Salt Lake is denser than pure normal water by about 2, and the water of crystallization of native borax tetrahydrate (rasorite), by about 7 parts per million.

A differential pycnometer method for measuring differences in density with a precision of one part in one million is described.

PORTABLE DETECTOR FOR RADIUM

Hospitals and other institutions using a large number of radium preparations are occasionally confronted with the problem of finding one when lost. These preparations are usually in the form of hollow metal needles 1 or 2 millimeters in diameter and 15 to 30 millimeters long. When lost, they are difficult to find except by means of their gamma radiation. In the past, it has been customary to do this by using an electroscope. The electroscope is slow and tedious to use, however, since it must be recharged every time it is read, and the rate of motion of the gold leaf timed with a

stop watch. RP663 in the March number of the Journal of Research describes a simple amplifier and light-weight ionization chamber which enables one to find a radium preparation merely by watching the pointer of a meter as a small ionization chamber is moved about. When the chamber approaches the radium, the pointer begins to move up the scale until it reaches the top when the chamber is directly over the radium. By using this device, a radium preparation can be located in a very few minutes, even when only vague information is available as to where it may be.

JOINT MEETING OF INSTITUTE OF RADIO ENGINEERS AND AMERICAN SECTION, INTERNATIONAL SCIENTIFIC RADIO UNION

On page 18 of Technical News Bulletin No. 202 (February 1934), notice was given of the arrangements made for a joint meeting of the Institute of Radio Engineers and the American Section of the International Scientific Radio Union in Washington on April 27. A preliminary program has now been arranged, consisting of two sessions at 10 a.m. and 2 p.m., at the building of the National Academy of Sciences, 2101 Constitution Avenue. The following papers are scheduled:

The development and characteristics of 9 cm radiation. C. R. Kilgore (Westinghouse Co.).

Vacuum tubes for generating frequencies above 100 megacycles. C. E. Fay and A. L. Samuel (Bell Telephone Laboratories).

Facsimile radio observations during the 1932 eclipse. E. F. W. Alexander (General Electric Co.).

Notes on propagation at a wave length of 73 centimeters. B. Trevor and R. W. George (Radio Corporation of America).

Some recent work on the ionosphere in Canada. J. T. Henderson (Canadian National Research Council).

Studies of the ionosphere by multi-frequency automatic recording. T. R. Gilliland (Bureau of Standards).

Ionosphere measurements at low altitudes. L. V. Berkner and H. W. Wells (Carnegie Institution of Washington).

High frequency ammeter. H. M. Turner (Yale University).

The thermal method of measuring the losses in a vacuum tube. F. P. Cowan (Harvard University).

Frequency standard and monitor stations of Canadian Radio Commissions. Col. W. A. Steel (Canadian National Research Council).

A method of measuring noise levels on short wave telegraph circuits. H. O. Peterson (Radio Corporation of America).

Relative daytime intensities of atmospherics. K. A. Norton (Bureau of Standards).

Developments in automatic sensitivity control. G. E. Pray (Signal Corps Laboratories).

Phase angle of vacuum tube transconductance at very high frequencies. F. B. Llewellyn (Bell Telephone Laboratories).

A new method of obtaining the operating characteristics of power oscillators. E. L. Chaffee and C. N. Kimball (Harvard University).

A short-cut method for calculation of harmonic distortion of modulated radio waves. I. E. Mourontseff and H. N. Kozanowski (Westinghouse Co.).

Space-charge effects in piezo-electric resonators. W. G. Cady (Wesleyan University).

ERRORS IN GAS ANALYSIS

RP661 in the March number of the Journal of Research presents experimental data on the loss, by solution, of certain gases in the rubber connections and stopcock lubricant of volumetric gas analysis apparatus. It is shown that errors which may be serious result whenever high concentrations of carbon dioxide, ethane, ethylene, acetylene, propane, propylene, or butane are present in such apparatus. A method of obtaining an approximate correction by means of a blank analysis is proposed. This correction improves the accuracy of the analysis, but with gases which are very soluble, such as propylene and butane, the results, while improved, are still very unsatisfactory.

SEPARATION OF RUTHENIUM FROM PLATINUM, PALLADIUM, RHODIUM, AND IRIIDIUM

The Bureau has recently developed a method for the separation and gravimetric determination of ruthenium. While the method of separation resembles existing methods in that the ruthenium is distilled as the volatile tetroxide, RuO_4 , it differs essentially from them in the type of solution from which the distillation is made.

The customary procedure has been first to distill a solution strongly acid with nitric acid, thereby eliminating osmium, which likewise forms a volatile tetroxide, and then to make the residual solution strongly alkaline, satu-

rate it while cold with chlorine and distill again to remove ruthenium. During the distillation of ruthenium from such a solution a precipitate consisting of the hydrated oxides of iridium, rhodium, and palladium separates as the hot alkaline solution becomes saturated with chlorine. The precipitate formed under these conditions carries with it some of the ruthenium and it becomes necessary to cool the solution, to add fresh alkali, and to repeat the saturation with chlorine. This treatment must be repeated a number of times without certainty of complete removal of the ruthenium.

In the method developed at the Bureau and which will be fully described in RP654 in the March number of the Journal of Research, the ruthenium is distilled from a solution of its sulphate in diluted sulphuric acid to which sodium bromate is added. Under these conditions, iridium, rhodium, and palladium remain in solution. In the preparation of the solution, by heating until vapors of sulphuric acid are evolved, platinum is precipitated as metal, but it was found that its presence had no effect on the separation of the ruthenium. It was further found that the entire distilling operation can be conducted at the boiling temperature of the solution and that a period of 2 hours is necessary and sufficient.

The tetroxide of ruthenium, which is liberated, is caught in a solution of diluted hydrochloric acid saturated with sulphur dioxide. Ruthenium is recovered from this solution, after evaporation and decomposition of sulphite compounds, by hydrolytic precipitation in a boiling solution having an acidity of pH 6. The hydrated oxide formed is carefully ignited to an anhydrous oxide and reduced to metal under hydrogen.

SEPARATION OF PLATINUM, PALLADIUM, RHODIUM, AND IRIIDIUM FROM ONE ANOTHER, AND THEIR GRAVIMETRIC DETERMINATION

A method for the analytical separation of platinum, palladium, rhodium, and iridium from one another, and for their gravimetric determinations has been developed in the Bureau's laboratory.

This separation of platinum from palladium, rhodium, and iridium differs essentially from the older methods and is based upon the behavior of these metals in a boiling solution containing sodium bromate and having an acidity of pH 6. Under these condi-

tions, palladium, rhodium, and iridium are completely precipitated as hydrated dioxides, while platinum remains in solution. In careful work the precipitation of the hydrated dioxides is repeated in order to remove a small amount of platinum which contaminates the first precipitate. Only in unusual cases is it necessary to make a third precipitation. The method can be used to separate platinum from all three of the metals simultaneously, or from each singly.

Platinum is recovered from the hydrolytic filtrates by precipitation with hydrogen sulphide, after decomposing the sodium bromate present with hydrochloric acid. The sulphide is ignited to metal and weighed as such. As described in RP655 in the March number of the Journal of Research, it was found that metallic platinum produced by the ignition of its sulphide retained, on the average, about 0.5 mg of sulphur, with quantities weighing 250 mg. In careful work it is recommended that the metal formed by igniting the sulphide be dissolved and precipitated again, this time by formic acid in a solution buffered with sodium acetate.

Palladium is quantitatively separated from rhodium and iridium, in a solution of the hydrolytic precipitate in diluted hydrochloric acid, by a single precipitation with dimethylglyoxime. The palladium can be determined by weighing the glyoxime compound, dried at 110 C, and using the theoretical factor, 0.3167. Palladium can be determined as metal by igniting the dried glyoxime compound carefully in air, then in hydrogen, and finally in carbon dioxide. The difficulty which attends the determination of palladium as metal by ignition in hydrogen is avoided by the subsequent ignition in carbon dioxide. During this last ignition, absorbed hydrogen is eliminated and a silvery gray metal results.

The filtrate from the palladium precipitation, containing rhodium and iridium, is evaporated until vapors of sulphuric acid are evolved and treated with nitric acid to destroy organic matter. From the resulting solution, diluted and heated to boiling, rhodium is quantitatively precipitated as metal by titanous chloride. The rhodium is dissolved in boiling concentrated sulphuric acid and again precipitated. Two such precipitations were found sufficient to separate rhodium completely from iridium. The rhodium is again dissolved in sulphuric acid, the resulting solution diluted with an

equal volume of concentrated hydrochloric acid and twice its volume of water, and boiled; and the rhodium is then precipitated with hydrogen sulphide. Rhodium cannot be completely precipitated from the diluted sulphate solution, so that it is necessary to convert it to chloride. The rhodium is finally determined as metal. Iridium is recovered by hydrolytic precipitation, after the elimination of titanium by cupferron, and determined as metal.

The determination of rhodium and/or iridium can be simplified if the solution containing these two metals can be divided conveniently into aliquot parts. In one portion, rhodium and iridium are simultaneously precipitated as hydrated dioxides and determined as a metallic mixture. Rhodium must be determined separately, however, in another portion of the solution by the method outlined above.

DETERMINATION OF SMALL AMOUNTS OF ZINC IN STEELS AND IRONS

As metallurgical science advances, attention is being directed more and more to the effects of small amounts of impurities on the properties of metals. Although zinc has sometimes been mentioned as a possible constituent of steels and irons, little information appears available on methods for its determination in these materials.

To provide needed information in this field, the Bureau has investigated three procedures for the determination of small amounts of zinc in steels and irons. The first procedure, which involved the removal of iron by ammonium hydroxide, was found to be rapid and sufficiently accurate for the usual commercial determinations of zinc over a range of 0.005 to 0.30 percent. The second procedure, in which iron is removed by extraction with ethyl ether, was found to be the most satisfactory for amounts of zinc of the order of 0.001 percent. The third procedure, in which the zinc is precipitated by hydrogen sulphide in the presence of iron, gave satisfactory results with 0.003 percent, or more, of zinc in 15-g samples.

The results of analysis of four representative materials showed that if ordinary steels and irons contain any zinc the amount is not over 0.0005 percent. For a complete description of these procedures, RP664 in the March number of the Journal of Research should be consulted.

THERMAL EXPANSION OF BEARING BRONZES

Bronze and leaded bronze bearings are found in many types of machines. The comparatively high melting points and strength of these alloys make them more suitable for various purposes than the weaker and lower melting point white metals. Leaded bronzes find wide application on railroads, in the automotive industry, and in stationary machinery.

An investigation on the linear thermal expansion of bearing bronzes (copper-tin and copper-tin-lead alloys) was undertaken at the Bureau in order to supply a demand for data. Data were obtained at various temperatures between room temperature and 200 C (392 F). The work is described in RP665 in the March number of the Journal of Research. The results obtained on heating and cooling are shown in two figures, and the coefficients of expansion for various temperature ranges are given in a table. The following conclusions are obtained:

1. The expansion curves in the first heating of cast bronzes are in most cases above the observations obtained in the first cooling.

2. The coefficients of expansion obtained in the second heating are generally higher than those obtained in the first heating.

3. The addition of tin to copper, or lead to copper-tin alloys increases the coefficients of expansion.

4. The following equations show the relationship between the tin content and the coefficients of expansion of cast copper-tin alloys:

$$_{20}^{\infty}\alpha_{100} = (17.03 + 0.0646 S_n) 10^{-6}$$

$$_{20}^{\infty}\alpha_{200} = (17.47 + 0.0585 S_n) 10^{-6}$$

In these equations, $_{20}^{\infty}\alpha_{100}$ and $_{20}^{\infty}\alpha_{200}$ represent the average coefficients of expansion from 20 to 100 C and from 20 to 200 C, respectively, and S_n represents the percentage of tin between 0 and 15 percent.

5. The following equations show the relationship between the lead content and the coefficients of expansion of cast leaded bronzes with a copper-tin ratio equal to about 7:

$$_{20}^{\infty}\alpha_{100} = (17.76 + 0.0475 P_b) 10^{-6}$$

$$_{20}^{\infty}\alpha_{200} = (18.16 + 0.0355 P_b) 10^{-6}$$

In these equations, $_{20}^{\infty}\alpha_{100}$ and $_{20}^{\infty}\alpha_{200}$ represent the average coefficients of expansion of leaded bronzes from 20 to 100 C and from 20 to 200 C, respectively, and P_b represents the percentage of lead between 0 and 20.50 percent.

6. With the aid of figures 5 and 6 of this Research Paper it is possible

to predict the coefficients of expansion of other cast copper-tin and copper-tin-lead alloys.

BEHAVIOR OF FLAT STEEL-PLATE FLOOR UNDER LOADS

Although it is often claimed that building construction has not progressed as rapidly as other forms of engineering, considerable attention has been given during recent years to applying methods which have proved successful for other structures to the construction of residences and commercial buildings.

The American Institute of Steel Construction, Inc., has developed a type of floor known as the battledeck floor. It consists of steel I-beams to which flat steel plates are welded along the middle of the upper flange. In cooperation with the Institute a loading test was made at the Bureau on one battledeck floor to measure its strength, and to determine whether the floor behaved as a unit when loads were applied. This floor, having a span of 18 feet, consisted of 4-inch 7.7 lb/ft rolled steel I-beams spaced 2 feet apart. These beams supported rolled steel plates having a width of 2 feet and a thickness of $\frac{1}{4}$ inch. Electric arc welds joined the plates and the I-beams along the middle of the upper flange of each beam.

The floor was loaded with pigs of cast iron, and strain-gage and deflection readings were obtained for live loads up to 200 lbs/ft². The load was then increased to 420 lb/ft² with no indication of collapse.

The strain gage and deflection readings gave no indication that this floor did not behave as a unit when loads were applied. There was no visible indication that the welds either ruptured or deformed permanently.

Provided the spacing of the beams does not exceed 100 times the thickness of the plate, this test indicates that for ordinary spans the entire width of the plate may be assumed effective when designing a flat steel-plate floor of the type described. A more complete account of this work will be published as RP662 in the March number of the Journal of Research.

TENSILE TESTS OF SOLDERED SPECIMENS

Tensile tests were recently completed at room temperature and at 400 F on specimens butt-soldered with a recently developed brazing alloy containing silver which is claimed to be particularly adapted for hard solder-

ing of copper, brass, bronze, and other nonferrous alloys not damaged by temperatures of 1300 F, the flow point of the solder. At 400 F specimens of copper soldered to copper broke some distances away from the joint. In all of the other tests, the fractures occurred partly through the solder, partly between the solder and the basis metal and partly in the basis metal, and indicated that the butt-soldered joints were approximately as strong as the basis metal (copper or brass) adjacent to the joint.

SIMPLIFICATION OF CUPOLA REFRACTORIES

Simplified Practice Recommendation R154-34, Cupola Refractories, has been accorded the required degree of written approval by the industry, and is to become effective March 15, 1934. This recommendation which was proposed and developed by the industry covers the sizes and shapes of cupola lining blocks, tap-out, and slag-hole blocks. The recommendation represents a substantial reduction in the variety heretofore listed for regular stock purposes, especially for tap-out and slag-hole blocks.

SIMPLIFIED PRACTICE RECOMMENDATION FOR SIEVE SIZES OF CANNED PEAS

Simplified Practice Recommendation R149-33, covering sieve sizes of canned peas, is now available in printed form. This recommendation, which was proposed and formulated by the industry, lists the sieve opening sizes to be used in separating peas into three size groups, designated respectively as small, medium, and large. The new "small" size combines the old size numbers 1 and 2 in both the Alaska type and sweet varieties of peas. The "medium" size replaces the old size number 3 of the Alaska type and the combined size numbers 3 and 4 of the sweet varieties. The combined old size numbers 4 and 5 of the Alaska type, and 5 and 6 of the sweet varieties are designated as "large" in the new schedule. Copies of this recommendation may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., for 5 cents each.

STANDARDIZATION OF WOVEN-FABRIC UNDERWEAR

The woven wear division of the Underwear Institute established a research associateship at the Bureau on July 11, 1933, for the purpose of de-

veloping standard minimum measurements for the various types of woven-fabric underwear to be incorporated in the industry's code under the National Industrial Recovery Act. It was believed that these standards would lessen unfair competition among manufacturers and lead to greater satisfaction to the users of the garments.

The procedure has been to determine the current practice by means of questionnaires circulated by the Institute to all manufacturers of woven underwear. Garments were then made up conforming as closely as possible to the average of all the measurements obtained. These garments were laundered and carefully scrutinized by the standardization committee from the industry, working under the chairmanship of Wallace J. Ross. The measurements were revised in the light of the practical experience of the members of this committee, additional garments were made up for further consideration, when necessary, and finally a set of minimum measurements were adopted that should give garments having proper fit both before and after laundering.

The standardization committee held 15 meetings from July 1933 to January 1934, inclusive, and there were two meetings of the whole woven wear group to ratify the recommendations of the committee. The standards were accepted by the group and have become a part of the industry's code.

The garments for which minimum measurements have been established are as follows: Men's woven shorts, boys' woven shorts, men's woven shorts (center seam back only), men's woven union suits (closed crotch, knit webbing in back only), boys' woven union suits (closed crotch, knit webbing in back only), men's woven union suits (closed crotch, knit webbing in back only, button shoulder), men's woven union suits (open hinged blouse back, side opening), men's woven union suit (closed blouse back, side opening), and children's woven waist suits (1, flat crotch line, drop seat garment, and 2, leg division, drop-seat garment).

Similar work for the knit underwear group of the Institute is now in progress. Standards are being developed for ladies' and children's garments not covered by the knit underwear standards of Commercial Standard CS33-32, previously worked out through a research associateship at the Bureau. Some of the old standards are to be revised in the light of experience. Essentially the same pro-

cedure as that followed in developing the woven fabric underwear will be used. It is expected that these new standards will become a part of the code under the N.R.A. as they are completed.

**NEW AND REVISED PUBLICATIONS
ISSUED DURING FEBRUARY 1934**

Journal of Research¹

Bureau of Standards Journal of Research, vol. 12, no. 2, February 1934 (RP nos. 639 to 652, inclusive). Price 25 cents. Obtainable by subscription.

Research Papers¹

(Reprints from November and December 1933 Bureau of Standards Journal of Research)

RP609. Tests on a reinforced-concrete arch of the Arlington Memorial Bridge; C. C. Fishburn and J. L. Nagle. Price 5 cents.

RP611. The stability of levulose in aqueous solutions of varying pH; J. A. Mathews and R. F. Jackson. Price 5 cents.

RP614. The isolation of mesitylene, pseudocumene, and hemimellitene from an Oklahoma petroleum; B. J. Mair and S. T. Schickel. Price 5 cents.

RP615. The attraction between coils in the Raleigh current balance; C. Snow. Price 5 cents.

RP617. Infrared absorption spectra of some plant pigments; R. Stair and W. W. Coblenz. Price 5 cents.

RP618. Preparation of calcium lactobionate and lactobionic delta-lactone; H. S. Isbell. Price 5 cents.

RP619. Phase equilibria in the systems TiO_2 , TiO_2-SiO_2 and $TiO_2-Al_2O_3$; E. N. Bunting. Price 5 cents.

RP623. Consistency of potato-starch size; W. T. Schreiber, M. N. V. Gelb, and O. C. Moore. Price, 5 cents.

RP624. Arc spectrum of silicon in the red and infrared; C. C. Kless. Price, 5 cents.

¹ See footnote in next column.

RP626. Effect of heat treatment on the expansivity of a pyrex glass; J. B. Saunders and A. Q. Tool. Price, 5 cents.

RP627. Evaluation of manila-rope fiber for color; G. Becker and W. D. Appel. Price, 5 cents.

RP629. Radio observations of the Bureau of Standards during the solar eclipse of August 31, 1932; S. S. Kirby, L. V. Berkner, T. R. Gilliland, and K. A. Norton. Price, 5 cents.

Simplified Practice Recommendations¹

R149-33. Sieve sizes of canned peas. Price, 5 cents.

Technical News Bulletin¹

Technical News Bulletin No. 201, January 1934. Price, 5 cents. Obtainable by subscription.

OUTSIDE PUBLICATIONS²

Becker, Genevieve, and Appel, W. D., Evaluation of manila rope fiber for color and "Becker value", Cord Age (114 East 32d St., New York, N.Y.), vol. 24, no. 2, p. 25, February 1934.

Saeger, C. M., and Ash, E. J., Properties of gray cast iron as affected by casting conditions, Transactions, American Foundrymen's Association (222 West Adams St., Chicago, Ill.), vol. 5, p. 449, February 1934.

McAllister, A. S., The services of the Division of Specifications to Federal, State, county, educational, and municipal purchasing agencies, Educational Business Manager and Buyer (6306 Cottage Grove Ave., Chicago, Ill.), vol. 13, no. 2, p. 7, February 1934.

¹ Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D.C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, \$2.50 per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama; other countries, 70 cents and \$3.25, respectively).

² "Outside publications" are not for sale by the Government. Requests should be sent direct to publishers.

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